SCULPTURE AS MUSIC INTERFACE

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ABSTRACT

This paper describes the conception, design and implementation of a number of hardware/software musical interfaces and their use in performance with a group of dancers and as units for public interaction. It investigates the design and development of such interfaces.

The work examines the nature of digital interfaces for musical expression through the use of sculptural forms and ideas, using multiple and diverse sensors, the data from which is used to generate and control multifarious musical parameters in software. It notes relationships between the sculptural forms and the musical material produced. The combination of control of musically expressive algorithms through hardware design, combined with the expressive potential of dance and embodied movement is of particular interest.

1. INTRODUCTION

As a musician whose love of music grew from experiencing live performance using an acoustic instrument as well as enjoying the social structures of orchestras and bands, the tempting freedom of electronic music has always been tempered by a perhaps reluctant realisation that electronic music in general and computer music in particular has been a solitary pursuit. On a more visceral level, a musician's interaction with a physical acoustic instrument is a very different experience from that of manipulating a computer via keyboard, mouse or any other conventional tool of interaction.

One of the key issues defining viscerality is the learning of particular physical and mental functions so well that they become autonomous [7, 18]. This enables musicians to perform otherwise extraordinary feats of physical and mental dexterity).

In terms of the investigation of interfaces for music it would seem to be that the challenge is not only to develop new instruments, but new possibilities of interaction. An interface does not have to be a musical instrument. In the case of the sculptures described, these are neither compositions nor instruments, just as a sculpture is neither a performance nor a tool.

2. IMPLEMENTATION

All the devices described here are a combination of hardware and software. The hardware is in reality a simple device that converts some physical property into electricity. This voltaic process is then sampled and the resulting digitised information can be used to generate material directly or to control algorithms.

The Gaggle interface was originally conceived as an improvisatory interface for the control of generative music. Procedures would control specific aspects of the music including pitch, duration and timbre, and an important aspect of these is the recreation of those musical characteristics that make live performance so satisfying, including indeterminacy, the varied repetition of melodic, rhythmic and timbral material and the encapsulation of global structures such as the length and order of particular groups of material.

Wire is a prototypical sculptural interface conceived and designed from the outset specifically bearing in mind the needs of performance with a unit that has a distinct visual presence.

With this in mind, the design involved consideration both of how the item would look and how the performers (primarily dancers, but also visitors and spectators) would interact.

Gaggle, Gagglina and Wired are implemented using ultrasonic sensors, homemade touch sensors amongst others. Physical sensing is undertaken using Arduino hardware. The data created 'manipulates' music algorithms written using the SuperCollider audio language [16].

These devices are described in detail elsewhere [8, 9]. The Metapiano, a new device and one of the primary focuses of this paper, is discussed below.

3. SCULPTURE

Although unintended, it quickly became apparent that the physical form of the Gaggle was important, and that this appearance had sculptural implications. One onlooker immediately called it 'Hydra' after the nine-headed mythical creature, and many visitors have found these devices intriguing visually as well as aurally; there is a clear assumption that physical appearance is tightly linked to audible response.

The appearance of acoustic musical instruments is itself important, as demonstrated by the extent to which music performers from all backgrounds and utilising all styles consider their visual impact (in terms of both clothing and instrument). Visual artists such as Picasso [19] and Marclay [15] have used the forms of musical instruments and notation in their work, and as might be expected kinetic sculptures, and especially those including sonic elements by artists such as Jean Tinguely have been particularly evocative. Tinguely has also been influential because of his precipitate

interest in algorithmic and mechanical processes as established in his 'meta-matical' works such as 'Méta-Malevitch' [21].

Another influence has been the work, and in particular the hanging mobiles, of Alexander Calder (see figure 2). His delicate creations, many of them wire-based mobiles and wall sculptures, are ideal for investigation of sensor based music solutions, but alternatively, more monumental shapes and figures might be as exciting.

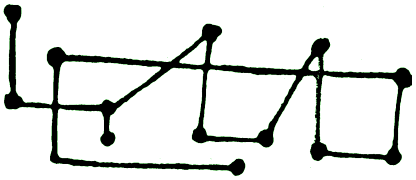

Figure 1. Stravinsky's sketch of his own music

A feature uniting these various creations is their emphasis on a particular type of structure – perhaps reflecting the relative physical complexity of musical instruments and so (metaphorically) implying a certain type of musical result. Stravinsky's glyph of his own music (figure 1) [6] provides an interesting comparison to the Figure 2. It is certainly true that there are passing resemblances to some parts of the music created by the Gaggle, etc. and the modernism of Stravinsky's late music.

The author has collaborated with a number of sculptors, for instance Douglas Jeal [12], who has constructed maquettes of potential interfaces from coloured perspex and utilising coloured light as a primary interface: the interaction is determined by ambient lighting and that reflected from the dancers' floridly decorated costumes.

4. INTERACTION

4.1. Interaction with the devices

The devices mentioned above have been used in performance on a number of occasions, enabling some interesting, if informal analysis of interactions with them. It would appear to be the way that the human thinks about their role that is of crucial significance in deciding the purpose, quality and function of the device. If the human feels they are a performer who would expect to spend some time learning and understanding the interface, maybe working hard at particular features in order to achieve particular technical ends, then they will have very different expectations from someone who is pleased to generate interesting sounds without too much effort having just wandered into a gallery. Two of the most common initial responses are delight (particularly from non-musicians), and scepticism ('where's the learning' – that part of the pleasure of playing a musical instrument is the learning of it). Interestingly, a number of visitors commented that their positive experience was enhanced by their view that the music produced 'sounded nice' in contrast to what they felt was the often harsh and aggressive sound world of some electronic music.

4.2. Metaphor

The nature and relevance of metaphor in the interface has been analysed on many occasions [3], sometimes specifically regarding audio environments [1]. One of the effects of this application of metaphor is the encouragement of expectations. If an object (usually in the virtual domain) behaves like an object (usually in the real domain) in a convincingly realistic way, a series of expectations can arise that other behaviours will be similar.

As an example of this, visitors, some even quite technically literate, have immediately assumed that the devices are actually producing the sound that they hear. This seems very much a consequence of the fact that they feel that the response of the unit is quite physically related to changes in the sound and that therefore the unit must itself be responding: in effect, the unit *might as well be producing the sound*. This demonstrates the power of what some might call a metaphorical equivalence with the fact that objects in the real world (for instance musical instruments) make their own sound.

Another illustration would be the perceived link between proximity and intensity. In performances the Gaggle has been set up so that the closer you were to the unit, the greater the amplitude of the resulting music, metaphorically reflecting the general human experience that 'closeness' implies 'intensity'.

As an example the dancers circled the Gaggle with some velocity, sweeping their arms up and down outlining 'waves' around the unit. This suggested that the dancers felt (accurately) that more movement indicated a greater number of audio events. So, the metaphor used in this particular case was that greater movement means greater sonic activity. The movement reflects the 'design' of the unit in so far as circling it is the best way of creating movement in its proximity. On another occasion the dancers utilised the same movement, but in a different location: a circling motion conducted away from the device. The sonic result here was that only a part of the audio material was created in the way that it was from the movements previously described. It resulted in a form of echo of that material but with some aspects missing and others radically altered: there was significantly less timbral modulation, for instance [9].

Bearing these examples in mind, what does it mean for a metaphorical link between form and function to exist? There is a balance to be drawn between the interface metaphor 'making sense' and therefore helping the performer use the resources available, and a more playful approach where part of the joy of investigation is in the discovery of stimulating responses and

behaviours. On the one hand we have traditional musical instruments: attractive and successful, but usually very difficult to become expert in [7]; on the other we have new technologies: playful, analytical, metaphorical. Above all else, we can have the viscerality of the physical world linked to the abstract world of computation, which 'empowers users with creative and magical potential' ([3], p.511).

4.2.1. The metapiano and magic

What might be considered 'magical' in a musical device? The 'Metapiano' is a large composite sculptural unit composed of a number of devices, including one - 'Leaves' - which is based in part on hanging mobiles produced by Alexander Calder. A typical example of this type of Calder's 1960 work is 'The Star', (see figure 2). In the 1960s Earle Brown undertook a similar project in his 'Calder Piece' [4].

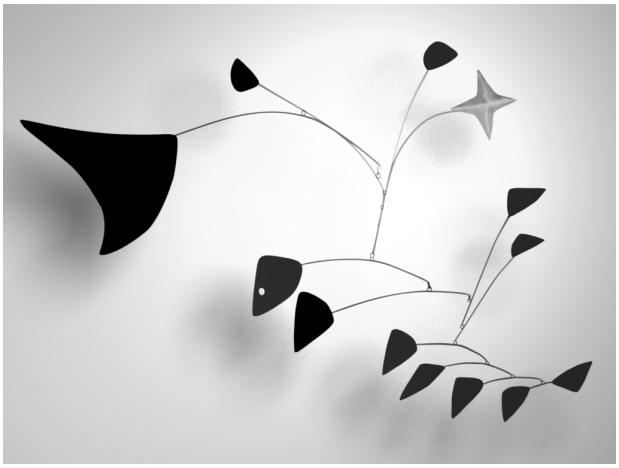

Figure 2. Alexander Calder, The Star, 1960

The metapiano is 'played' by dancers and/or members of the public through a variety of sensory interactions including touch, proximity and light. The unit algorithmically creates melodies, harmonies and textures to be played using synthesised sounds on SuperCollider. Different parts of the metapiano are intended to control different aspects of the musical texture: piano-like, pedal-like low tones, lighter more melismatic ideas, single notes and chords and non-piano-like background textures, for example.

A simple isomorphic interaction might mean single notes, each 'leaf' triggers a certain tone, the harder the touch, the louder the amplitude, the higher physically the leaf, the greater the frequency of the tone. To an extent this is already a part of the structure: the 'leaves' are a hanging mobile, so they will be high physically, and in turn they are generally high frequency events; quite melismatic and decorative in intention. However, they are also intended to be 'magical' – the performer, whether dancer or member of the public, is able to interact with the units with little or no experience and in doing so, create an extemporization that they would be unable or unlikely to do otherwise.

Another important factor is the mapping and control of multiple parameters. One of the features of acoustic instruments is that, while in comparison to their technological counterparts they can seem simple, in reality they are not. We have become used to these interactions and tend to ignore their most important features – most obviously, the quantity of information available from any 'simple' expression. This information comes about through the use of continuous control information on a set of simple but continuous and multiple parameters. A flute has a fixed number of finger holes, but the breath control is continuous and infinite. There are many ways of controlling a flute's tone: it is the most significant factor in expression on the instrument. A good musician practices until using these continuous controls is no longer necessarily a conscious procedure. Lower level activities such as fingering and breathing become automated, allowing increased concentration on higher-level tasks such as musical expression.

One of the main experimental strategies in developing the new units here described is the mapping of controllable parameters in particular areas and using particular sensors so that conscious control of all parameters is more challenging. This is intended to encourage freedom of expression and less concern over direct and precise conscious control of all parameters, so intentionally distinguishing the units from standard acoustic musical instruments.

5. RELATED WORK

The interfaces presented here follow Perry Cook's original fifth 'principle' for music controller design: "write music, not controllers" [5]. The first of Cook's principles from the same paper is that "programmability is a curse" - 'real' instruments can be 'programmed' to only a very limited extent, anything else is a synthesiser.

The concept of coherence between interface and result from Koleva [13] is important, particularly when considering its complex role in the creative process. In metaphor and magic, Blackwell [3] and Antle [1] include very clear discussion while Ishii [11] and Hunt and Wanderley [10] include seminal information regarding mapping.

For an approach on systems of algorithms on a number of levels, see Rohrhuber [20].

Aspects of the devices have been inspired by the theremin, the work of Harry Partch [17] and to and extent, the Baschet Brothers [2].

6. CONCLUSIONS AND FUTURE WORK

One of the principal areas of development arising from this work involves a continuing investigation into how we interact with objects in a musical and performance-based manner. A significant part of this involves the 'learning' of 'procedural' knowledge: those things we

have become so practised in that we do not need to think about them.

In collaborations between artists and musicians there needs to be a significant level of partnership in the process and inevitably at times the two art forms collide. Sculpture might be seen as one of the least ephemeral of the arts and therefore the least appropriate for association with music – especially at the level of interaction suggested here. On the other hand, the example of kinetic and sonic sculpture indicates that there is a tolerance for these objects. Of crucial significance is how much of this tolerance is because kinetic sculptures with sonic components use the material of which the sculpture is made.

The issues determining the success of any such collaboration will almost certainly involve the nature of any of these supposed metaphorical links and how they balance with the essential nature of each object: sculpture and music.

7. REFERENCES

[1] Antle, A., G. Corness, et al. "What the body knows: Exploring the benefits of embodied metaphors in hybrid physical digital environments." *Interacting with Computers* 21(1-2): p.66-75., 2009

[2] Baschet, F. and Baschet, B. "Sound Sculpture: Sounds, Shapes, Public Participation, Education." *Leonardo*: p107-114, 1987

[3] Blackwell, A. "The reification of metaphor as a design tool." *ACM Transactions on Computer-Human Interaction (TOCHI)* 13(4): p.490-530, 2006

[4] Brown, E., *Calder Piece*, [Online]: http://www.earle-brown.org/works.focus.php?id=33, [retrieved 10 May 2011], 1966

[5] Cook, P. "Principles for Designing Computer Music Controllers." *On-line Proceedings of New Interfaces for Musical Expression Workshop (NIME 01),* 2001.

[6] Craft, R. and Stravinsky, I. *Conversations with Igor Stravinsky*. London, Faber Music in Association with Faber and Faber, 1979.

[7] Ericsson, K. *The road to excellence: the acquisition of expert performance in the arts and sciences, sports, and games*. Mahwah, N.J., Lawrence Erlbaum Associates, 1996.

[8] Hoadley, R. "Implementation and Development of Sculptural Interfaces for Digital Performance of Music through Embodied Expression", *Electronic Visualisation and the Arts, London*, 2010.

[9] Hoadley, R. "Form and Function: Examples of Music Interface Design", *Proceedings of the British Computer Society Human Computer Interaction Conference, 2010, Dundee*, 2010.

[10] Hunt, A., . Wanderley, M., and Paradis, M. "The importance of parameter mapping in electronic instrument design", *Conference on New Instruments for Musical Expression (NIME-02), Dublin, Ireland*, 2002.

[11] Ishii, H., and Ullmer, B. "Tangible Bits: Towards Seamless Interfaces between People, Bits, and Atoms". *Proc. of CHI'97, ACM*, 1997.

[12] Jeal, D. *Sketches for Sculptural Interfaces*, [Online]:http://rhoadley.net/comp/metapiano/# maquettes [retrieved 10 January 2011], 2010.

[13] Koleva, B., Benford, S. et al. "A framework for tangible user interfaces", *MobileHCI conference 2003, Udine, Italy*, Citeseer, 2003.

[14] Loy, G. *Musimathics : the mathematical foundations of music*. Cambridge, Mass. ; London, MIT Press, 2006.

[15] Marclay, C., *Lip Lock*, Paula Cooper Gallery, New York, 2000.

[16] McCartney, J. "Rethinking the Computer Music Language: SuperCollider." *Computer Music Journal* **26**(4), 2002.

[17] *Newband Instrumentatrium*. [Online], Available at: http://www.newband.org/instruments.htm [retrieved 7 June 2010], 2010.

[18] Pascual-Leone, A. "The brain that plays music and is changed by it." *Ann N Y Acad Sci* 930: 315-329, 2001.

[19] Picasso, P. *Guitar*, Artists Rights Society (ARS), New York, 1914.

[20] Rohrhuber, J., de Campo, A., Hall, T. "Dialects, Constraints and Systems within Systems", *The SuperCollider Book*. N. Collins, Cottle, D., and Wilson, S. (eds), Cambridge, Mass, MIT Press, 2011.

[21] Tinguely, J. *Méta-Malevitch* [Online]: http://www.tinguely.ch/en/museum_sammlung/sammlung.1954-1959_03.html, [retrieved 20 January 2011], 1954.